

Prevalence and patterns of morbidity among adults in Germany

Results of the German telephone health interview survey German Health Update (GEDA) 2009

ESM Infobox

This article contains two additional tables with detailed information on the age- and sex-specific prevalence of individual health conditions and disease categories. The supplemental information is available at dx.doi.org/10.1007/s00103-012-1464-9

Background

The epidemiologic transition is marked by major changes in patterns of morbidity and mortality [1]. For the longest time, malnutrition and infectious diseases were the main threats to human health and society. Comparatively recently, improved living conditions and breakthrough advances in infectious disease control were followed by large increases in average life expectancy and the emergence of chronic health conditions. In industrialized countries cardiovascular disease became the leading cause of morbidity and mortality by the middle of the past century. Since then, life expectancy, disease patterns, and major causes of death have undergone further albeit less dramatic changes and these changes are closely tied to economic and social conditions [1, 2]. In affluent societies like Germany, longevity to very old age has shifted the disease spectrum to delayed degenerative diseases and to the

coexistence of multiple health problems, also referred to as multimorbidity [3]. Comorbidity is often used interchangeably but more specifically relates to the presence of additional morbidities in relation to a given index disease [4].

Multi- and comorbidity have high public health relevance in aging populations [5]. Older persons are likely to suffer from one or more diseases, age-related functional impairments, systemic changes of the immune system, the endocrine system, and the ability to maintain salt and water balance as well as an increase in the use of psychotropic drugs [6, 7, 8, 9, 10]. Not surprisingly, an increasing number of coexisting health conditions among older persons is associated with disability, poorer health outcomes and quality of life, and higher health care utilization [2, 5, 11, 12]. Health care systems need to adapt to the challenges of age-related changes in health problems and associated health care needs [2, 13, 14, 15]. For this, population-based data on common patterns of chronic health conditions are needed. Therefore, assessment of morbidity in the population requires a shift from individual health conditions to comorbidity. Using data from the German telephone health interview survey “German Health Update (GEDA) 2009”, we determined the prevalence and patterns of

chronic health conditions among adults in Germany in a population-based cross-sectional study.

Methods

As part of the continuous national health monitoring, the Robert Koch Institute regularly conducts telephone health interview surveys in representative samples of the German adult population (German Health Update, GEDA) [16]. These cross-sectional studies complement other cross-sectional and longitudinal health interview and examination studies such as the German Health Interview and Examination Surveys for Adults (DEGS, <http://www.rki.de/degs>), and the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) [17].

Study design and study population

GEDA 2009 was funded by the German Federal Ministry of Health and carried out between July 2008 and June 2009. During that time, a total of 21,262 participants were interviewed by specifically trained interviewers who were closely supervised according to guidelines from the Behavioral Risk Factor Surveillance System of the Center of Disease Control and Preven-

Health condition	Disease category
Hypertension, hypercholesterolemia, diabetes, obesity (BMI ≥ 30)	Cardiometabolic conditions
Myocardial infarction (MI), angina pectoris or any other coronary heart disease, chronic heart failure, stroke	Cardiovascular disease
Asthma, chronic bronchitis	Lower respiratory disease
Chronic liver disease, chronic renal disease	Liver/renal diseases
Gastritis, gastric ulcer	Upper gastric disease
Osteoarthritis, rheumatoid arthritis, osteoporosis, chronic back pain	Musculoskeletal disease
Lifetime medical history of any type of cancer	Cancer
Depression	Depression
Severe hearing or visual impairment	Severe sensory limitations

	Women		Men		All	
	(n)	(% ^a)	(n)	(% ^a)	(n)	(% ^a)
Five age groups (years)						
18–29	1,956	16.2	1,833	18.6	3,789	17.3
30–49	4,867	34.7	3,451	37.5	8,318	36.0
50–64	2,961	21.8	2,158	23.0	5,119	22.4
65–74	1,592	17.1	1,224	14.8	2,816	16.0
75 and older	738	10.2	482	6.1	1,220	8.2
Two age groups (years)						
18–49	6,823	50.8	5,282	56.1	9,148	53.4
50 and older	5,291	49.2	3,864	43.9	12,114	46.6
All	12,114	51.5	9,148	48.5	21,262	100.0
Socio-economic status^b						
	(n)	(%)	(n)	(%)	(n)	(%)
Low	1,475	22.5	910	17.4	2,385	20.0
Middle	7,174	60.9	4,775	59.0	11,916	60.0
High	3,451	16.7	3,461	23.7	6,867	20.0
Coexistent conditions						
	Median	Mean ^c (95% CI)	Median	Mean ^c (95% CI)	Median	Mean ^c (95% CI)
18–29	0	0.53 (0.48–0.57)	0	0.36 (0.32–0.41)	0	0.44 (0.41–0.47)
30–49	1	0.98 (0.93–1.03)	0	0.89 (0.83–0.94)	0	0.93 (0.90–0.97)
50–64	2	2.24 (2.15–2.33)	2	2.10 (1.98–2.22)	2	2.17 (2.10–2.25)
65–74	3	3.39 (3.21–3.57)	2	2.91 (2.72–3.10)	3	3.17 (0.30–3.30)
75+	4	3.79 (3.55–4.03)	3	3.14 (2.87–3.41)	3	3.56 (3.37–3.74)
All	1	1.81 (1.76–1.86)	1	1.58 (1.53–1.63)	1	0.44 (0.41–0.47)

^aWeighted estimates to represent the German population; ^bMissing data for 94 participants (0.4%), proportions refer to participants with complete information; ^cValues are adjusted for age; CI confidence interval.

target [18], using a highly standardized protocol. The target population consisted of adults 18 years of age and older who were living in private households with landline telephones and could fluently speak German. In a two-stage sampling procedure,

sampling at the household level was performed by a random digit dialling method [19] and the last-birthday method was applied for sampling at the individual level [20]. A total of 140–236 questions (depending on age, sex, and the number of

reported conditions) covered a range of health topics and health-related variables, including medical history and current body weight and height for calculation of body mass index (BMI) estimates, and sociodemographic variables. Specifically, information was collected on a total of 22 health conditions (18 medical diagnoses, 3 health problems, BMI) that commonly take a chronic or recurrent course and that can be expected to have a prevalence of at least 2% in the adult population in Germany. Overall 53.2% of eligible individuals completed a computer-assisted telephone interview (CATI). The study was approved by the federal and local office for data protection. All participants gave oral informed consent prior to study participation.

Data collection and definition of study variables

The mean interview duration was 31 min. Covering a list of 18 medical diagnoses, participants were asked whether a physician had ever told them that they had the disease and whether it had been present within the past 12 months. Lifetime prevalence estimates were determined for diagnoses which commonly represent irreversible organ damage or underlying chronic progressive disease processes (stroke, myocardial infarction (MI) or other coronary heart disease, any type of malignant disease). For all other diseases (hypertension, hyperlipidemia, diabetes mellitus, chronic heart failure, asthma, chronic bronchitis, chronic renal disease, chronic liver disease, gastritis/duodenitis, gastric/duodenal ulcer, osteoarthritis, rheumatoid arthritis, osteoporosis, depression), prevalence estimates represent the 12-month prevalence, in order to assure capturing of current health problems. Regarding a definition of hypertension and hyperlipidemia, information on current medication use was also obtained and considered. Questions regarding a history of osteoporosis were limited to study participants 50 years of age and older. In addition, three symptomatic health problems were assessed. These included self-reported chronic back pain for at least 3 months within the 12 months preceding the interview as well as self-report-

ed severe hearing and vision impairment as assessed in the European Health Interview Survey (EHIS) [21]. Finally, current BMI was calculated based on self-reported height and weight. Obesity was defined as a BMI ≥ 30 kg/m² [22].

Socioeconomic status (SES) was classified as low, middle, or high based on educational and professional status and the net household income adjusted for household size [23].

The 22 health problems assessed were grouped into 9 disease categories as defined by organ systems or disease entities as shown in **Tab. 1**. Multimorbidity was defined as the presence of two or more concurrent health conditions in one person and quantified by adding up the numbers of coexisting individual conditions per person (morbidity count). Comorbidity was defined on the basis of disease categories as having health conditions in one or more disease categories in addition to health problems in an index disease category. For estimates at the level of disease categories, persons with more than one health condition within the same disease category were counted only once unless stated otherwise.

Statistical analysis

We calculated the age- and sex-specific prevalence rates and 95% confidence intervals for individual health conditions as well as for disease categories. For analysis of comorbidity patterns, all possible combinations of comorbidity dyads and triads were calculated. Combinations reaching a prevalence of at least 5% for comorbidity dyads and at least 2.5% for comorbidity triads are reported here. For age specific analyses, five age groups were defined: 18–29, 30–49, 50–64, 65–74, ≥ 75 years. Analyses of comorbidity patterns were restricted to comparisons between younger and older adults using a cut-off of 50 years of age (< 50 vs. ≥ 50 years). In order to represent the adult residential population of Germany, data were weighted to adjust for sampling design and non-response. Analyses were conducted using PASW Statistics (version 18.0.3, SPSS Inc., Chicago, IL, USA) with the Complex Samples module.

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Prevalence and patterns of morbidity among adults in Germany. Results of the German telephone health interview survey German Health Update (GEDA) 2009

Abstract

To describe the prevalence and patterns of morbidity among adults in Germany, we collected self-reported information on 22 chronic health conditions in a nationally representative health survey among 21,262 participants (51.5% women, aged 18–100 years). Age- and sex-specific prevalences were calculated for single health conditions, disease categories, the most prevalent disease dyads and triads, and for multimorbidity defined by condition count. In both sexes, hypertension, hyperlipidemia, chronic back pain, obesity, and osteoarthritis were the most prevalent single health conditions and significantly increased with age. Cardiometabolic and musculoskeletal conditions were the two most prevalent disease categories in all age and sex groups. The most prevalent disease category dyads and triads included combinations between cardiometabolic conditions, car-

diovascular and musculoskeletal disease, depression, sensory limitations, and cancer. The prevalence and magnitude of multimorbidity strongly increased with age in both sexes. Among German adults, the prevalence of chronic health conditions varies greatly by age and sex. In contrast, patterns of morbidity and comorbidity differ according to age, but are highly consistent between men and women. The predominant role of cardiometabolic conditions in all groups underlines the need for preventive efforts. The co-occurrence of chronic health conditions among older is highly prevalent and this calls for tailoring health care towards specific disease combinations.

Keywords

Prevalence · Morbidity · Chronic conditions · Multimorbidity

Krankheitsprävalenzen und -muster bei Erwachsenen in Deutschland. Ergebnisse der Studie Gesundheit in Deutschland aktuell 2009 (GEDA 2009) des Robert Koch-Instituts

Zusammenfassung

Zur Beschreibung von Krankheitsprävalenzen und -mustern bei Erwachsenen in Deutschland wurden Informationen zu 22 chronischen Gesundheitsproblemen bei 21.262 Personen im Alter von 18 bis 100 Jahren (51,5% Frauen) telefonisch erhoben. Alters- und geschlechtsspezifische Prävalenzen wurden für einzelne Gesundheitsprobleme, Krankheitsgruppen, häufigste Kombinationen und Vorliegen von Mehrfacherkrankungen (Multimorbidität) ermittelt. Die insgesamt häufigsten und mit dem Alter zunehmenden Gesundheitsprobleme waren bei Männern und Frauen Bluthochdruck, Hypercholesterinämie, chronische Rückenschmerzen, Adipositas und Arthrose. Die Gruppe der kardio-metabolischen und muskuloskelettalen Erkrankungen dominierten in allen Alters- und Geschlechtsstrata. In Zweier- und Dreierkombinationen finden sich außerdem häu-

fig kardiovaskuläre und maligne Erkrankungen, Depression und schwere Seh- oder Hörbeeinträchtigungen. Mit zunehmendem Alter steigt die Prävalenz multimorbider Personen. Während die Prävalenz chronischer Erkrankungen nach Alter und Geschlecht variiert, unterscheiden sich Krankheits- und Komorbiditätsmuster nur nach Alter. Das Überwiegen kardio-metabolischer Erkrankungen unterstreicht die Notwendigkeit präventiver Ansätze. Ältere sind besonders von Multimorbidität betroffen, was eine gezielte Abstimmung der gesundheitlichen Versorgung auf Menschen mit bestimmten Krankheitskombinationen erfordert.

Schlüsselwörter

Prävalenz · Morbidität · Chronische Krankheiten · Multimorbidität

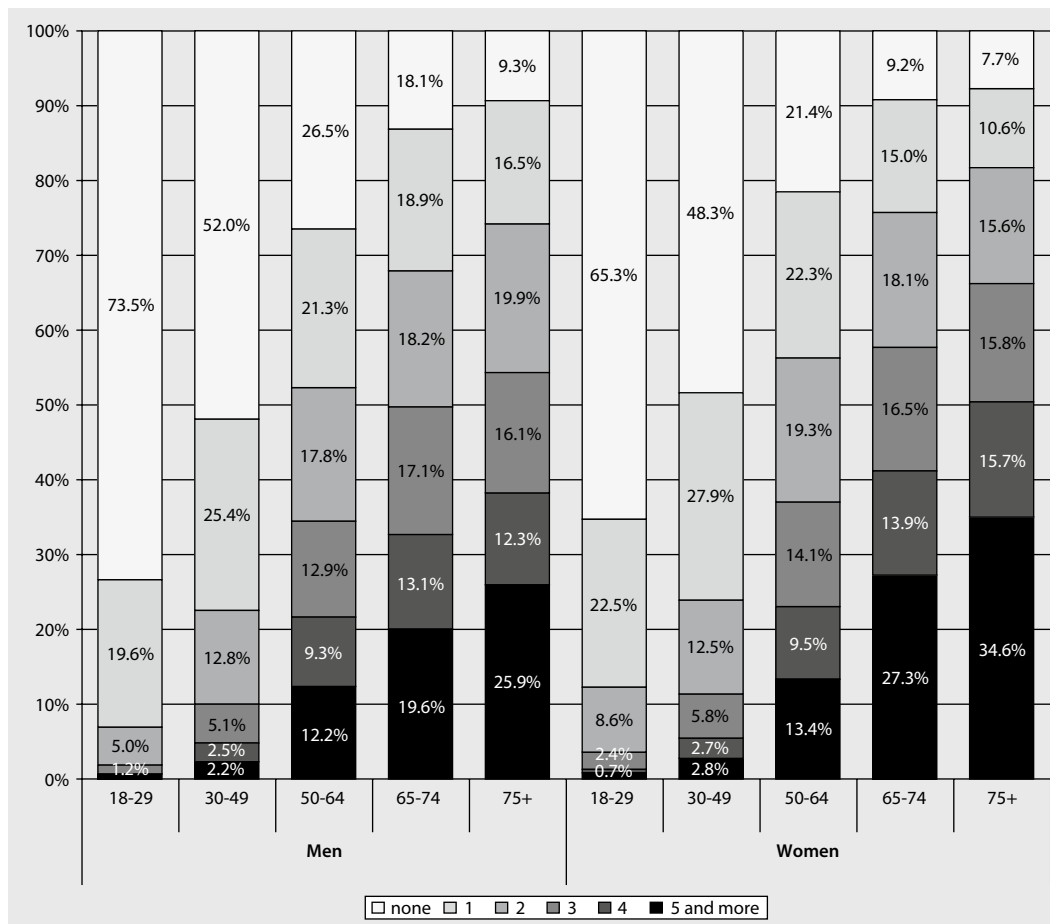


Fig. 1 ◀ Number of conditions/diseases (n=22) by sex and age group

Results

Characteristics of the study population are presented in **Tab. 2**. The study population consisted of 21,262 community-dwelling residents (51.5% women, 48.5% men) aged between 18 and 100 years. Mean age was 50.1 years for women and 47.6 years for men. A total of 24.2% (27.4% of women, 20.9% of men) were 65 years and older.

Overall, the single most prevalent health condition among both sexes was hypertension (women 26.3%, men 25.6%). Among men and women, further ranking of the five most frequent health problems included the same conditions but their order slightly differed: hyperlipidemia, chronic back pain, obesity, and osteoarthritis. Coronary heart disease (CHD) with or without myocardial infarction (MI) was the sixth most prevalent condition in men at 9.2% (women 6.5%). The sixth most prevalent condition in women was osteoporosis at 15.1%, which was

of minor importance among men (4.4%). Lifetime prevalence for any malignant disease was 8.4% for women and 5.3% for men. A diagnosis of depression within the 12 months preceding the interview was reported by 8.0% of women and 4.5% of men. Overall, 5.9% of women and 4.8% of men had a history of asthma. Health conditions with an overall prevalence of less than 2% included chronic renal and liver disease in both sexes, and hearing impairment among men. Detailed information on the age- and sex-specific prevalence of individual health conditions and disease categories is provided in supplemental **Tab. 1** and **Tab. 2**.

The five leading morbidities among young women and men (18–29 years) included chronic back pain, obesity, asthma, and depression as well as gastritis/duodenitis among women and hypertension among men. Among older adults, hypertension and hyperlipidemia ranked among the five leading morbidities in both sexes, along with osteoarthritis,

chronic back pain, obesity, and in men and women of the oldest age groups, coronary heart disease.

The prevalence of sensory limitations, coronary heart disease, stroke as well as cancer among men and hypertension, heart failure, osteoporosis, and rheumatoid arthritis among women significantly and continuously rose with increasing age. Other chronic conditions, including hyperlipidemia, obesity, diabetes mellitus, osteoarthritis, and chronic back pain showed a significant and positive increase in prevalence with age up to age group 65–74 years and a leveling thereafter. No significant association with age in either sex was observed for asthma, chronic bronchitis, depression, or upper gastric, chronic renal or chronic liver disease. Below age 50 years, women had significantly less hypertension and significantly more osteoarthritis, chronic back pain, and depression than men, while sex differences in older persons were characterized by significantly higher prevalence of all muscu-

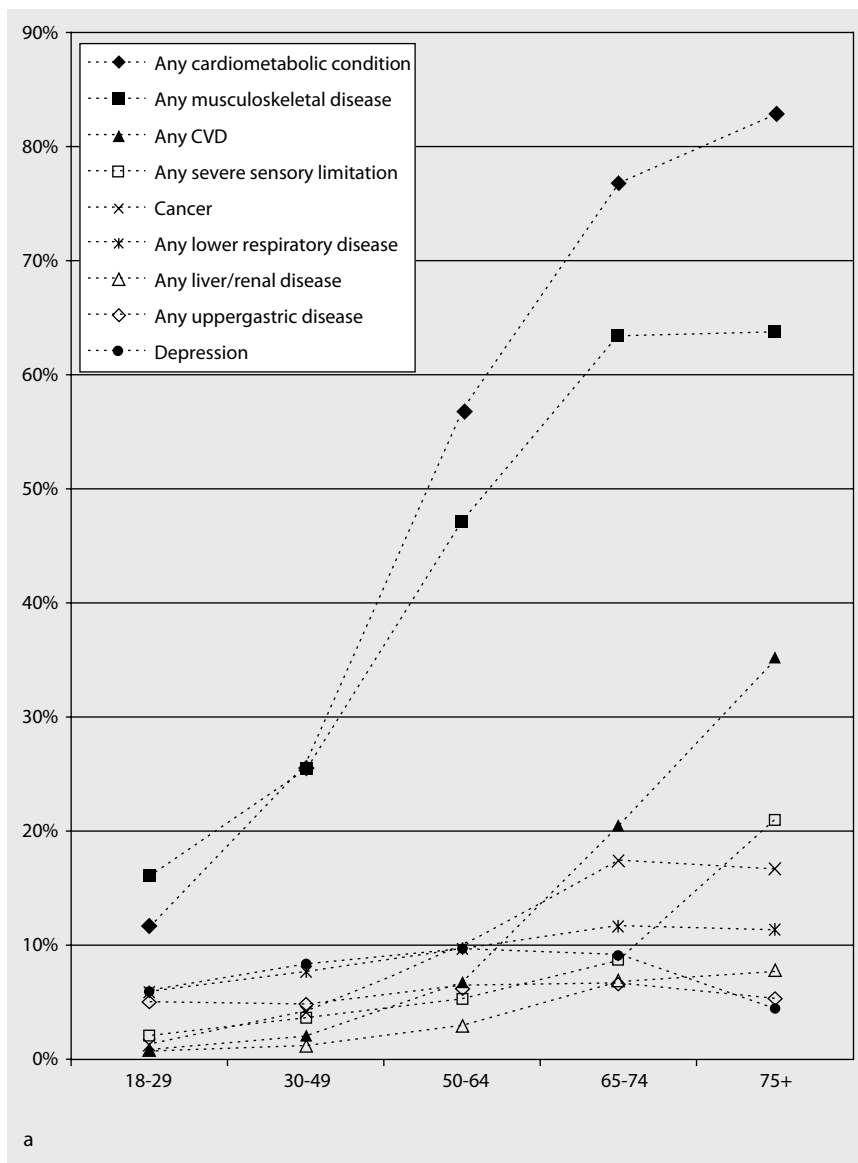


Fig. 2 ▲ Prevalence of disease categories by age groups: **a** women, **b** men. CVD cardiovascular disease

loskeletal conditions, hypertension, and hyperlipidemia and (up to age 75 years) lower prevalence of cardiovascular disease in women compared to men. Between age 30 and 74 years, women were also significantly more likely to have a history of malignant disease than men. This was particularly true for coronary heart disease, stroke, osteoporosis, and sensory limitations.

The number of coexistent health conditions ranged from 0–16. The median increased with age from 0 among participants 18–29 years old to 4 among women and 3 among men 75 years and older. The mean number of coexistent health conditions was significantly higher in wom-

en (1.89) than in men (1.52; $p = 0.000$). The age-adjusted comparison of means showed significant sex-differences in all age-groups except in the age group 30–49 years of age.

Overall, 43.9% of women and 36.3% of men had two or more chronic conditions. The prevalence and magnitude of multimorbidity increased with age in both sexes, particularly among persons 50 years of age and older (Fig. 1). Specifically, the prevalence of five or more health conditions rose from 1–2% in the two youngest age groups to 12–13% among men and women 50–64 years of age to 20% among men and 30% among women 65–74 years of age, and to more than 25% among

men and more than 34% among women 75 years and older.

The age- and sex-specific prevalence estimates based on disease categories are summarized in Fig. 2. In both sexes, a steady increase across age groups was evident for cardiovascular disease, chronic renal, or liver disease and in men musculoskeletal disease and cancer. This was also true for cardiometabolic conditions in women, although obesity and hyperlipidemia showed no further increase among persons in the oldest age group (supplemental Tab. 1 and Tab. 2). The prevalence of persons with any severe sensory limitation gradually increased from 1–2% among persons 18–29 years of age to 8–9% among those in the age group 65–74 years. It then steeply rose to 20.8% among women and 14.8% among men aged 75 years and older. No age-related increase in prevalence was observed for diseases of the lower respiratory or upper gastrointestinal tract or for depression, which showed a peak in middle age among both sexes (Fig. 2, supplemental Tab. 1 and Tab. 2).

Prevalence rates and proportions of persons with additional comorbidities according to specific index disease categories by sex and age strata (<50 vs. ≥50 years) are summarized in Fig. 3. The proportions of persons with and without additional comorbidities below age 50 years was below 5% for all conditions except for cardiometabolic, musculoskeletal, and lower respiratory conditions in both sexes and depression in women (Fig. 3a). In comparison, the prevalence of health conditions as well as the proportion of persons with additional comorbidities was generally higher among men and women 50 years and older. For example, the prevalence of cardiometabolic conditions with comorbidities in two or more other disease categories increased from 4.3% in women and 3.0% in men below 50 years of age to 28.9% in women and 23.1% in men aged 50 years and older (Fig. 3). The majority of older men and women with sensory limitations, depression, chronic liver or renal disease, chronic respiratory disease, or upper gastric disease had additional comorbidities in at least two other disease categories.

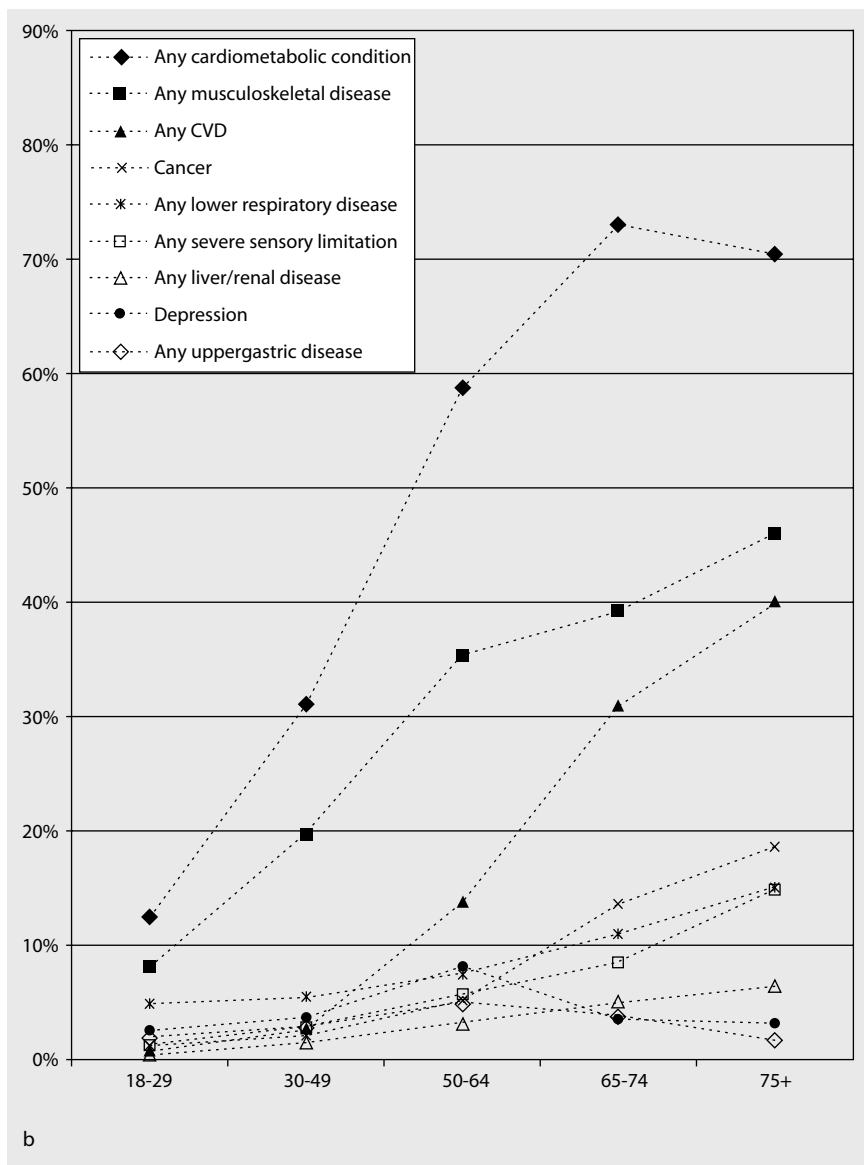


Fig. 2 ▲ Continued

The sex-specific prevalence of the most common combinations of comorbidity patterns is reported by age strata in **Tab. 3**. Among persons up to 50 years of age, only a combination of cardiometabolic conditions and musculoskeletal diseases occurred at a prevalence exceeding 5% (women 6.9%, men 5.6%). Among men and women 50 years and older, this particular comorbidity dyad was present in 41.6% of women and 27.6% of men. Less frequent combinations were observed for 11 other comorbidity dyads including combinations of cardiometabolic conditions and cardiovascular disease (women 15.3%, men 19.6%), and of cardiometabolic conditions and depression

(women 10.3%, men 7.3%). With respect to comorbidity triads, we found 11 combinations exceeding a prevalence of 2.5% among older persons as compared to no such combinations in the younger population. The most frequent comorbidity triads were combinations of cardiometabolic, cardiovascular, and musculoskeletal conditions (women 11.5%, men 9.5%), of cardiometabolic conditions, lower respiratory, and musculoskeletal disease (women 6.7%, men 3.7%), and of cardiometabolic conditions, musculoskeletal disease, and depression (women 6.7%, men 3.3%).

Discussion

The present study describes prevalences and patterns of morbidity and comorbidity among German adults 18 years and older. The single most prevalent health conditions among both sexes were hypertension, hyperlipidemia, chronic back pain, obesity, and osteoarthritis. They mainly showed a significant increase in prevalence with age up to age group 65–74 years and a leveling thereafter.

The prevalence of multimorbidity defined as two or more coexisting chronic health conditions increased similarly with age in both sexes. Above age 50 years, half of men and almost two-thirds of women had comorbidities in two or more disease categories. The most prevalent disease category dyads and triads included combinations between cardiometabolic conditions, cardiovascular, and musculoskeletal disease, followed by combinations with depression, sensory limitations, and cancer. Patterns of morbidity and multimorbidity were similar in both sexes, but multi- and comorbidity was more prevalent in women than in men.

Comparison of prevalence of single conditions with results from other studies

Comparisons of results on conditions between studies are limited because of considerable differences in data sources, time trends, age range, recruitment of study populations, study period, number and assessment of conditions, and definitions as far as cut-offs of blood pressure and serum lipid measurements. For the comparison of our results with those from other studies, we used data from German surveys as far as possible. With respect to individual health conditions, comparisons will focus on the highly prevalent conditions hypertension, chronic back pain, osteoarthritis, hyperlipidemia, obesity, and in women, osteoporosis.

In the present study, the prevalence of self-reported physician-diagnosed hypertension within the past 12-months or current antihypertensive treatment was 26.3% among women and 25.6% among men. These prevalence estimates are considerably lower than estimates from the

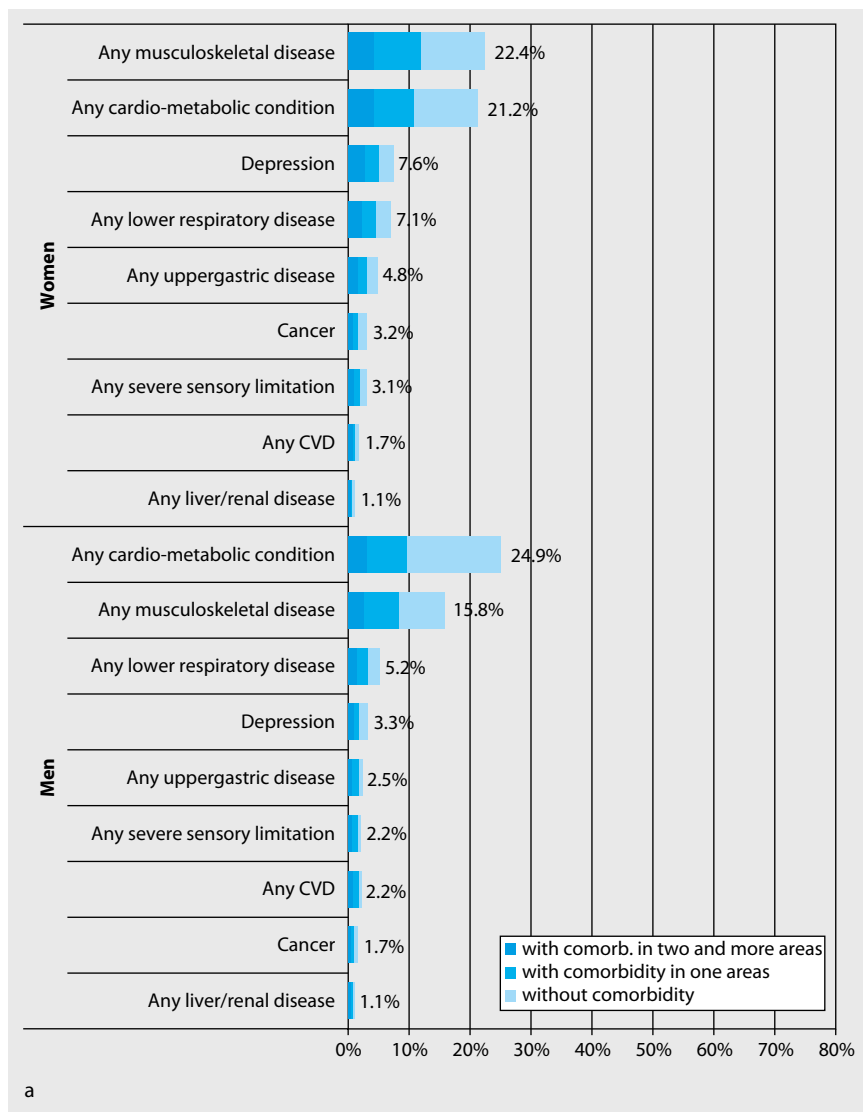


Fig. 3 ▲ Prevalence of disease categories without comorbidity (*light blue*), with comorbidity in one other category (*middle blue*), and with comorbidities in two or more other categories (*dark blue*) in participants **a** below 50 and **b** 50 and older. CVD cardiovascular disease

1998 German National Health Interview and Examination Survey (GNHIES 1998) that were based on standardized blood pressure measurements using cut-offs of 140 mmHg/90 mmHg [24]. The prevalence of hypertension based on blood pressure measurements in other German studies ranged from 28.6–38.5% for women, and from 41.4–60.1% for men [25]. Similarly, in GNHIES 34.9% of women and 32.2% of men had serum cholesterol levels exceeding 250 mg/100 ml [24] as compared to 21.8% of women and 19.8% of men reporting a medical history of hyperlipidemia within the past 12 months or current use of lipid lowering in the present study. It is obvious that estimates based on

self-report with or without consideration of medication use are likely to underestimate the prevalence of hyperlipidemia and hypertension due to underdiagnosis. In addition, some of the differences compared to previous studies may be due to changes in prevalence rates over time. However, focusing on the population 65 years and older, our prevalence estimates are similar to those observed in a recent analysis of claims data from a large German sickness fund [26] and results from previous German telephone health interview surveys [27].

It is well known that people tend to underestimate their weight and overestimate their height, which leads to low-

er prevalence of overweight and obesity in studies based on self-reported data compared to studies in which height and weight were measured [28]. It is, therefore, likely that our prevalence estimates of obesity are underestimated as well. However, obesity prevalence estimates derived from our study (women 15.7%, men 16.3%) are approaching the results of the most recent German microcensus survey which are also based on self-report (women 13.8%, men 15.7%) [29].

In the telephone health survey 2003 (GSTel03), 21.6% of women and 15.5% of men reported to suffer from chronic back pain [30]. Estimates observed in the present study are slightly higher (women 24.5%, men 16.6%), possibly due to the higher mean age of the GEDA09 population compared to the GSTel03 population.

In GEDA09, 23.1% of women and 13.7% of men had osteoarthritis. Similar prevalence estimates were observed in the GSTel03 survey (women 23.2%, men 15.9%).

Lifetime prevalence of osteoporosis in GSTel03 was 14.2% among women aged 45 and older, rising from 3.4% for the age group 45–54 to 23.7% in the age group 75 and older [31]. Data for men were not available in this previous survey. The Augsburg MONICA study which included persons aged 25–74 reported an overall lifetime prevalence of 7% in women and 1% in men [25]. In the present study, the 12-month prevalence of osteoporosis was assessed in persons aged 50 years and older and is slightly higher compared to previous studies.

Multimorbidity and patterns of morbidity

As there is no agreed gold standard to assess multimorbidity, results are likely to differ between studies due to methodological issues. Differences relate to the definition of multimorbidity, the number and types of included health conditions, and the method of data collection (e.g., information based on self-report or abstracted from claims data). There is evidence that the prevalence of multimorbidity is substantially lower when estimated in a general population compared to the primary care setting [32]. In Germa-

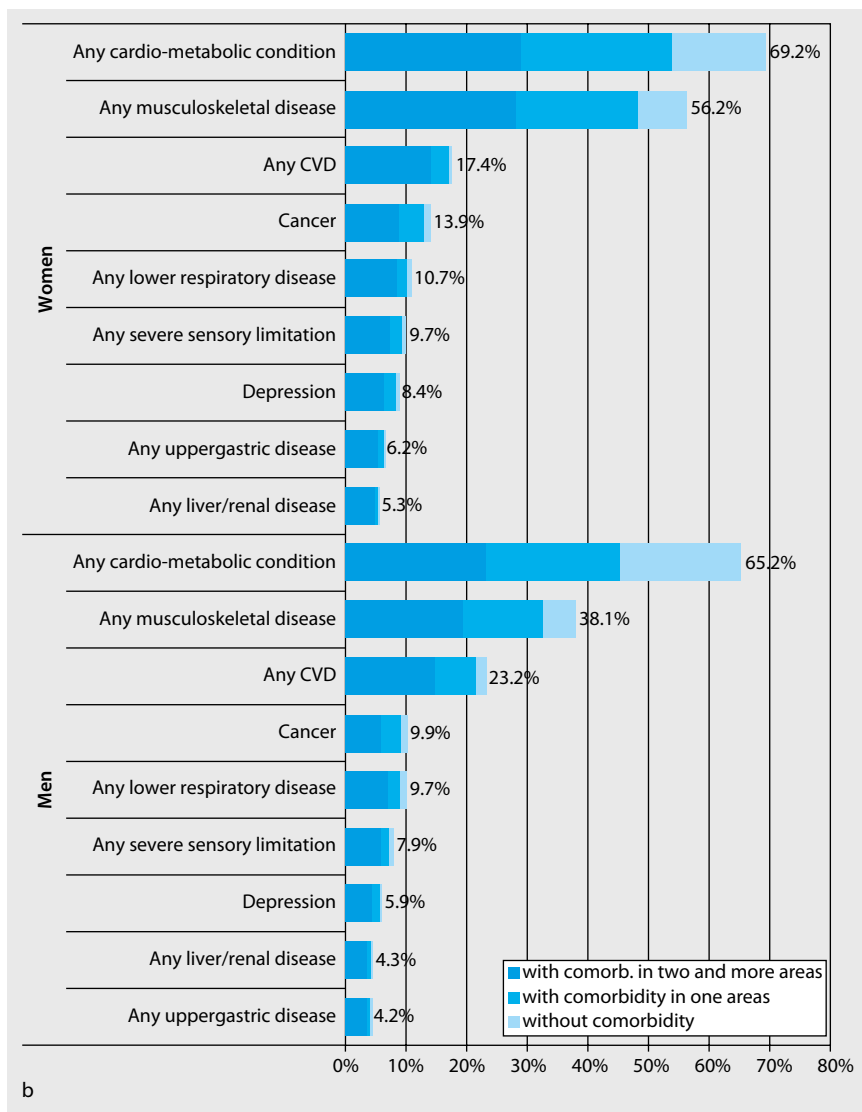


Fig. 3 ▲ Continued

ny, these differences are probably smaller due to the overall high utilization of ambulatory medical care [33]. For these reasons, study results are not directly comparable [11, 34].

A recent review found that prevalence of multimorbidity (defined as two or more concurrent diseases) in older persons ranged from 55–98% [5]. In a recent British retrospective cohort study using the Johns Hopkins University Adjusted Clinical Groups (ACG(R)) Case-Mix System based on combinations of conditions occurring in individuals [35], 58% had multimorbidity [36]. Another study in Ireland found a prevalence of 66.2% in patients over 50 years of age [37]. In a recent German study based on claims data, 62% of persons aged 65 and older had

multimorbidity defined as at least 3 diagnoses out of a list of 46 chronic conditions [38], as compared to 74.6% of participants 65 years and older in the present analysis. Most of the recent German epidemiological studies show an increase of multimorbidity with age but prevalence estimates differ considerably [2, 26, 38].

While multimorbidity is increasingly recognized as a public health problem of aging societies, the distribution and combination of concurrent health conditions still does not receive sufficient attention [5]. In Germany, the GSTel03 already demonstrated the high prevalence of multimorbidity and the importance of a combined analysis of conditions. In this previous survey of adults 18 years and older, a total of 16 condi-

tions were grouped into 10 disease categories. Overall, 16.8% of the respondents did not report any of the included conditions, 56.4% reported conditions in one or two, 22.4% in three and 4.5% in four or more disease categories with an increase by age groups [39]. In a recent German study based on claims data, the authors used different criteria to define disease categories; however, morbidity patterns were similar to those observed in the present study [38].

Strengths and limitations

The assessment of 22 different conditions in more than 21,000 participants facilitates the analysis of multimorbidity. Nevertheless analyses are limited due to small numbers within some age- and sex-specific groups. We focused on prevalent health conditions, hence less prevalent but severe chronic diseases, such as multiple sclerosis or Parkinson's disease were not included in the survey questionnaire interview.

Only community-dwelling people with at most light cognitive impairments and who were able to take part in the German-language interview participated in the study. Persons with dementia, severely ill or limited persons who were hospitalized or living in institutions (e.g., nursing home residents) with a possible higher burden of disease were not included in our study.

In our study, the mean number of co-existent health conditions was significantly higher in women than men. Several previous studies have reported sex differences in the prevalence of chronic conditions that are in line with our results [40, 41, 42]. A recent publication comparing the prevalence of chronic conditions in different countries found that women were more likely to report arthritis and depression, whereas men were more likely to report diseases of the heart [43]. In a German study based on claims data, men had a higher prevalence of coronary artery disease than women across all age groups. A higher prevalence of heart failure and hypertension among women than men was restricted to higher age groups [44]. There is evidence that women do not simply over-report morbidity [45, 46]. Our study underlines the importance of

Tab. 3 Prevalence of disease categories

Cardio-metabolic conditions	Cardio-vascular disease	Lower respiratory disease	Liver/renal diseases	Upper gastric disease	Musculo-skeletal disease	Cancer	Depression	Severe sensory limitations	Prevalence (%; 95% CI)	
									Women	Men
Frequent combination of 2 disease categories (Prevalence of more than 5%)										
People up to 50										
X					X				6.9 (6.1–7.7)	5.6 (4.8–6.5)
People 50 and older										
X					X				41.6 (39.8–43.5)	27.6 (25.8–29.5)
X	X								15.3 (13.9–16.8)	19.6 (17.9–21.3)
	X				X				12.6 (11.3–14.0)	10.9 (9.7–12.3)
X							X		10.3 (9.2–11.6)	7.3 (6.3–8.4)
					X		X		8.6 (7.6–9.7)	4.5 (3.8–5.4)
X		X							8.5 (7.5–9.7)	7.1 (6.1–8.3)
		X			X				7.7 (6.8–8.8)	4.9 (4.0–5.9)
X								X	7.4 (6.4–8.5)	5.9 (4.9–7.0)
					X			X	6.8 (5.8–7.9)	5.0 (4.2–6.1)
					X	X			6.5 (5.7–7.5)	3.6 (2.8–4.5)
X						X			6.3 (5.5–7.3)	4.4 (3.6–5.3)
				X	X				5.1 (4.3–6.0)	3.1 (2.4–3.9)
Frequent combination of 3 disease categories (Prevalence of more than 2.5%)									Women	Men
X	X				X				11.5 (10.3–12.9)	9.5 (8.4–10.9)
X		X			X				6.7 (5.8–7.7)	3.7 (3.0–4.6)
X					X		X		6.7 (5.8–7.8)	3.3 (2.6–4.0)
X					X			X	5.3 (4.4–6.3)	4.1 (3.3–5.1)
X					X	X			5.1 (4.3–6.0)	2.8 (2.2–3.6)
X				X	X				4.1 (3.4–4.9)	2.4 (1.8–3.1)
X			X		X				3.8 (3.1–4.8)	2.0 (1.5–2.7)
X	X	X							3.3 (2.7–4.1)	2.8 (2.2–3.6)
X	X							X	2.9 (2.3–3.7)	2.2 (1.6–3.0)
	X	X			X				2.9 (2.3–3.6)	1.6 (1.1–2.2)
	X				X			X	2.5 (2.0–3.3)	1.8 (1.3–2.5)

considering and reporting sex and gender differences in morbidity.

Relying on self-reported medical diagnoses remains a problem as this bears the potential of over- and underreporting, leading to misclassification. We tried to minimize false positive answers by asking for a diagnosis given by a physician. Self-reported diagnoses as used in GEDA may underestimate prevalence due to limited knowledge of the participants. However, there is evidence that the method is an efficient way to estimate disease prevalence in epidemiological studies with good validity for some and less validity for other

conditions [47, 48]. Validation by physician records was beyond the scope of this study; in addition, medical records have their own limitations [49].

Practical implications

The results of our study underline the importance of a broad view on health and illness. Persons with multiple conditions may need more careful and synchronized assessment, diagnosis, and treatment. The co-occurrence of conditions in different categories has implications, for example, for prescribing med-

ication (awareness of polypharmacy and potential drug interaction as well as prescribing omissions) and setting priorities in treatment [50, 51].

Furthermore, the existence of different diseases and conditions are of great importance for epidemiological research. Research paradigms have to move from examining comorbidities to reveal comprehensive disease or condition groupings.

In cross-sectional studies such as ours, only associations between condition groups can be examined, but no causal pathways. In order to better understand

causes and symptoms, longitudinal designs are necessary.

To date there is no gold standard for collecting or analyzing morbidity patterns, although some valuable approaches exist [48, 52]. In order to assure comparability of study results between studies and over time, research needs to take on the task of developing evidence-based consensus criteria on which conditions should be included in epidemiological studies and how they should be categorized in analyses of morbidity patterns.

Conclusion

Chronic conditions and multimorbidity challenge the health care systems and societies all over the world due to increased life expectancy. In this nationally representative survey of German adults 18–100 years of age, cardiometabolic conditions (hypertension, hyperlipidemia, diabetes, and obesity) and musculoskeletal diseases (chronic back pain, osteoarthritis, rheumatoid arthritis, and among persons 50 years and older osteoporosis) were the two leading disease categories among men and women of all age groups. Morbidity among persons 50 years and older was further dominated by severe end-organ disease, mainly cardiovascular disease, cancer, lower respiratory diseases, and severe sensory limitations. Among persons younger than 50 years of age, only lower respiratory disease and depression consistently ranked among the four most prevalent conditions reaching prevalence rates between 3% and 8%.

When addressing multimorbidity, it is important to emphasize that not only the number but also the type of concurrent conditions matter. This has implications for health care and raises new hypotheses for future epidemiological research. Methodology for systematic assessment and analysis of morbidity patterns needs to be improved and internationally consented, in order to permit monitoring within study populations over time (e.g., German population) as well as comparisons between studies.

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